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ABSTRACT

There are fundamental differences in the forms of learning addressed by cognitive psychologists and educationalists. The phenomena explained by a psychological theory of learning are the successes of human cognition. The mechanisms posited are designed to account for how learning takes place, where the content of the learning is the physical and social world around us. Educational theories of learning usually concern students' failure to learn. The content of the learning that is supposed to take place is a different kind of world: the world of other people's ideas. Psychological theories of why people fail to learn an idea do not provide adequate explanation because of a key difference: the content in this case is not the "natural" environment of the real world to which the learner has immediate access but the world of academic ideas, an "unnatural" environment. The same cognitive capacities that work well in the natural environment do not in the unnatural environment. In education, students fail to learn at least partly because the environment does not afford learning. Instead of providing study skill courses, educators need to enrich students' means of access to the unnatural world of academic ideas. An 18-item reference list is included. (DB)

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THE DIFFERENT FORMS OF LEARNING IN PSYCHOLOGY AND EDUCATION

by
Diana Laurillard

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THE DIFFERENT FORMS OF LEARNING IN PSYCHOLOGY AND EDUCATION

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This paper was presented at the SRHE/BPS conference on 'Cognitive Processes in Student Learning', University of Lancaster, 1985, and is now published in J T E Richardson, M W Eysenck and D Warren Piper (eds) Student Learning: Research in Education and Cognitive Psychology. SRHE & Open University Press, 1987.

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INTRODUCTION

I want to argue that there are fundamental differences in the forms of learning addressed by cognitive psychologists and educationalists. The argument focuses on two aspects: the nature of the phenomena described, and the nature of the environments being learned.

The phenomena explained by a psychological theory of learning are the successes of human cognition. The mechanisms posited are designed to account for how learning takes place, where the content of the learning is the physical and social world around us. The phenomena investigated in research on student learning, on the other hand, usually concern failure to learn. The content of the learning that is supposed to take place is a different kind of world: the world of other peoples' ideas. To encapsulate the contrast: a psychological learning theory has to account for why everyone learns to tie their shoe-laces; an educational learning theory is concerned with why almost no-one learns to solve the Schroedinger Equation.

If we ask the question 'Why do people fail to learn X?', psychologists and educationalists are likely to give different kinds of answers. The assumption behind the theme of this conference is that the psychologist's answer will be useful to the educationalist. I want to argue that it is not, but that the educationalist can, nonetheless, make use of psychological learning theories. The argument goes like this

Why do people fail to learn X?

Psychological theories, especially information processing theories, tell us they fail to learn because they are not applying the necessary mechanisms, or not applying them appropriately.

Can we transfer those explanations directly to explain why students fail to learn?

The answer is no, because the content, the world of academic ideas, is an 'unnatural' environment.

The learner has immediate and elaborated access to the 'natural' environment of the real world and has evolved the cognitive capabilities appropriate to learning such an environment.

But access to the 'unnatural' environment of the world of academic ideas is extremely impoverished, by comparison, and the same cognitive capabilities do not work as well.

In education, students fail to learn, at least partly, because the environment does not afford learning.

The remedy implicit in this account is, therefore, instead of putting on study skill courses, to enrich students' means of access to the unnatural world of academic ideas.

Therefore: we need the theories of cognitive psychology to tell us how an environment affords learning. We can then use this to construct the means of access that will turn an unnatural environment into one that affords learning.

The remainder of the paper expands this argument. Since the argument rests on the idea of affordance, I want to discuss that first.

AFFORDANCE AND LEARNING

What does it mean to say an environment affords learning? The natural environment 'affords' the perception of itself by being immediately accessible to the observer. The theory of 'affordances', described by Gibson, is a way of accounting for the success of human cognition in learning about its natural environment. An 'affordance' is what the observer directly apprehends: ". . . what we perceive when we look at objects are their affordances, not their qualities" (Gibson 1979, p134). An affordance is a collection of properties "taken with reference to the observer" (Ibid, p.143). Thus, we apprehend 'graspability' first, and only later come to learn that this is composed of 'texture', 'size relative to the size of my hand', 'distance from me', 'form', substance', etc. The idea of affordance is not unlike the earlier ideas of 'demand character' (Koffka 1924), and 'valence' (Lewin 1936), which also recognised the importance of the meaning to the observer in the perception of an object. But there is a crucial difference, pointed out by Gibson: the earlier concepts located these peculiar relativistic properties in the mind of the observer, making them 'phenomenal' objects, since they clearly were not physical. Gibson makes the bolder assertion that an affordance is neither physical nor phenomenal, "neither an objective property nor a subjective property; or it is both if you like. . . It is equally a fact of the environment and a fact of behaviour" (Ibid, p.129). As long as there are no strict dualists among us, this is a reasonable conclusion.

It is also philosophically respectable, being mirrored, for example, in Merleau-Ponty's argument against the dualism of psychology (pre-1963). "What is artificial in the alternatives of psychology can be seen from the point of view which we have adopted. After the psychology-as-a-science-of-the-facts-of-consciousness has come the psychology-without-consciousness of Watson. . . It is not seen that, from the moment behaviour is considered in

its unity" and in its human meaning, one is no longer dealing with a material reality nor, moreover, with a mental reality, but with a significative whole or a structure which properly belongs neither to the external world nor to internal life" (Merleau-Ponty 1963, p.182). The idea of 'affordance' resolves the "artificial alternatives". Thus, the idea of affordance is in sympathy with current preferences in student learning for a phenomenological perspective.

The idea is also in sympathy with other psychological theories of learning which describe the process of learning as a number of mechanisms, both conscious and non-conscious, which operate on our perceptions, and direct the form of interaction we have with the world, to enable us to build new, and progressively effective behaviours. These include mechanisms and procedures, such as repeated practice, feedback systems, hypothesis-testing, trial-and-error, analogical reasoning, etc. What has characterised many of the mechanisms posited is a kind of 'automaticity', i.e. there is an acknowledgment of the symbiotic nature of the relationship between the human brain and the world, in the sense that the idea of affordance describes, which means that we cannot help but perceive an afforded percept, and we cannot help but learn an afforded behaviour.

One example is Schank's account of dynamic memory: learning takes place automatically as expectations created by past experience, i.e. scripts, fail in new situations, and dynamically alter memory. These modifications are produced by the 'reminding' experience, together with the explanation of the failure. The modifications count as learning, and will generate new behaviour in the next situation encountered (Schank, 1982).

A second example is the attempt to define learning in terms of production systems, where 'production rules' provide the mechanism that connects 'declarative' knowledge - what you know already, whatever is stored in long-term memory - with behaviour. A production rule is an 'IF... THEN... ELSE...' statement. Because production rules can take the validation of other rules as their argument, this simple mechanism can provide extremely complex structures capable of giving an account of how a new behaviour could be built up in response to a new stimulus, given a particular set of declarative knowledge (Anderson 1983). Again, the idea of automaticity underlies the account, as the process of learning 'runs', rather as a computer program runs, and failures are bugs, which could be, for example, the absence of a rule, or a faulty rule.

The automaticity that characterises many theories of learning in cognitive psychology is important because it is an acknowledgment that (i) the environment affords the original percepts, and perception remains unproblematic in these accounts, and (ii) the environment also affords the learning of more complex constructs and behaviours. Automaticity is the adjunct of affordance.

If we accept that in psychology we are talking about an environment that affords learning, then it becomes clear that transfer between psychology and education will be difficult, because in education, we have an unnatural environment that does not afford learning. That is the point I want to argue now.

NATURAL AND UNNATURAL ENVIRONMENTS

What are the key differences between natural and unnatural environments? By 'natural environment', I mean the physical and social world around us. It is

the environment that human beings typically learn to manipulate. The 'unnatural environment' I am concerned with here, is the world of academic ideas. As educationalists, we want to know why people learn or fail to learn physics, history, sociology.

The natural and the unnatural environment are distinguished by the fact that the former provides knowledge of the world, the latter provides knowledge of descriptions of the world. It is the difference between perceptual knowledge (of the physical world) and what I choose to call 'preceptual' knowledge (of the theoretical world). ['Preceptive' = 'mandatory; didactic; instructive', Shorter Oxford English Dictionary]. It is the knowledge of precepts that gives us so much trouble, and is what concerns educationalists. What makes them difficult is that they are not afforded to us in the way that percepts are.

The mechanisms of learning established by psychology are developed to describe the functioning of an organism that has a 'symbiotic' relationship with its environment - that is in its appropriate ecological niche, to use Gibson's metaphor. Cognitive psychologists elaborate the details of how the process of learning can and does work. But they take for granted the existence of the 'affordances' that make this possible. It is the affordances of the environment that are problematic for the educationalist. The learning of precepts is not equivalent to the learning of percepts.

It might, of course, be argued that learning precepts is rather like learning concepts, and certainly, cognitive psychology has made a considerable contribution to our understanding of conceptual learning. But again, this has usually related to those concepts afforded by the physical environment, such as conservation, and those afforded by the social environment, such as 'tact',

'hypocrisy', and so on. The mechanisms of concept learning have been studied in relation to, for example, attributional concepts which can be learned through instances and non-instances of the concept. But the mechanisms that are appropriate for learning 'red circle' must be quite different from those needed to master the concept 'molecule'. An attributional concept like 'red circle' can be learned from a domain of objects that include only red things, blue things, circular things and square things, because the domain can be partitioned into instances and non-instances of the concept, and the positive instances adequately describe the concept. But we cannot do the same thing for 'molecule'. It is not a concept that is adequately described in terms of its attributions. Its logical structure is more complex.

Thus the results of studies of concept learning cannot be transferred to education because (a) attributional concepts are too simplistic for that research to be relevant, and (b) more complex concepts, such as conservation, are in any case afforded by the environment. An individual only has to interact with the environment for sufficient time, and they learn the concept. It is therefore unlikely that the results of conceptual learning will transfer easily to preceptual learning.

A further aspect of cognitive psychology that should be relevant to education is the work on text processing. But how relevant is it? Much of this work has focused either on short texts - on sentences and paragraphs - or on simple texts, with a descriptive or narrative structure. There are no analytic methods for studying the processing of texts the length and complexity of a chapter in an academic textbook. Undoubtedly, the strategies we use for processing sentences play a part in the way we process chapters, but the complexity of the processing at the macro-level is too great to gain much from the micro-level descriptions. The linear structures of narratives, and

even hierarchic propositional structures, used for example by Meyer (1975), are far less complex than the rambling and untidy structures that underlie most academic texts. Unravelling those is likely to require a qualitatively different kind of cognitive processing. So again, text processing is unlikley to transfer directly to the learning of precepts.

Learning precepts is different from learning either percepts or concepts because our means of access to them are so limited. We cannot experience structuralism in the same way as we experience good table manners. We cannot experience molecules in the same way as we experience dogs. Because we have to rely on the artificial structuring of our experience of precepts, via academic texts for example, it is unlikely that the mechanisms we use in the natural environment will transfer directly to this unnatural environment. Thus our means of access to precepts becomes critical to our success in learning them.

THE MEANS OF ACCESS TO ACADEMIC KNOWLEDGE

I want to discuss examples drawn from recent research in student learning that demonstrate two ways in which preceptual and perceptual learning are different: the structure of the unnatural environment does not afford learning of preceptual knowledge; and the affordances that <u>are</u> provided afford the learning of things other than preceptual knowledge because our cognitive capabilities have been developed to deal with the affordances of the natural world, and they do not transfer to the unnatural world.

The unnatural environment I am referring to is the variety of educational media through which we gain access to preceptual knowledge. Lectures, text, problem-solving, essay-writing, laboratory practicals - are all ways in which we come to know the precepts of the academic world Of course, the

way that an academic text is structured hardly provides a transparent means of access to the precepts it is describing, and this causes many students to misinterpret what it is saying.

One common difficulty has been identified by Ference Marton and Roger Saljo. This is the inability to perceive the 'figure-ground' structure in a text. Many academic texts have this form, where the figure-ground refers to the principle-example, the main argument-evidence, the generalisation-instance. There have been several replicated studies of students learning from such texts and these show that within any group, some students will report the text as being about the principle, e.g. scientific method; others report the same text as being about the content of the example, e.g. the discovery of the causes of childbed fever in the 19th century (Marton and Wenestam 1979).

The same pattern has also been found in the context of a different medium, namely a television programme. When students were asked to summarise an educational television programme that had the main argument-evidence format, some of them described the main argument, namely that childrens' television is culturally determined - but others described it in terms of the evidence that was put forward, namely that Sesame Street is about working-class street-life, whereas Play School is about middle-class home-life (Laurillard 1983).

The figure-ground structure is certainly something that affords the perception of itself. It would be surprising if someone were unable to recognise the figure and the ground in a painting like the Mona Lisa. However, it is not particularly surprising that students have difficulty with the texts described above. In the first case, the principle takes up the title plus 5% of the text, the remainder being a description of the example. In the second

case, the statement of the main argument takes up about 5% of screen time, the remainder being used for programme extracts providing the evidence for the claim. Leonardo da Vinci had the sense to give the Mona Lisa more than 5% of the canvas. She would still have been figural, as is the main point in these examples, but, as the above educational examples show, it does not help the student's perception of the structure to make what is figural so insignificant relative to what is ground.

Academic texts often obscure the precepts they are describing, in such a way that it becomes surprising that students ever learn anything. They do learn things by using strategies specifically developed to overcome the deficiencies of the environment. Marton has described one of these strategies as 'deep-level processing'. It refers to a collection of activities such as 'looking for the main point', 'comparing one part of the text with another', looking for the structure', etc. And this is what the student has to do just to be able to see what the text is actually about - the equivalent of perceiving. This is not the same as learning, as being able to remember and apply and develop the precepts found in the text. Deep-level processing is what the student needs to do just to see what is there. It is not done by every student all the time. It is a strategy developed, presumably in the same way as our everyday cognitive capabilities, to be suited to the demands both of the environment and of the student's own interests and values. Students actually <u>want</u> to learn their subject, at least some of the time, and sometimes manage to find the intellectual apparatus necessary for doing this in the face of even the most obscurantist text. The problem for students is that so many academic texts obscure their structure. In other words, the unnatural environment fails to afford learning by making even the initial apprehension of the percepts difficult.

A second way it does this is by providing only very poor means of access to the manipulation of those precepts. Learning through problem-solving is one example (Laurillard 1984). Students should find that their normal problem-solving strategies, transferred from the natural environment, should be some help. But the 'unnatural' problems of the theoretical world are not usually set up appropriately for this. Students are not given the kind of problem that would allow them to operate on the environment as they would expect to.

For example: in learning about digital process control, students have to learn the language (assembler), the system analysis of the mechanism to be programmed (e.g. traffic light control), and the procedure for expressing this as a computer program. The problem they are faced with, if solved on a computer, is manipulable; it is amenable to trial-and-error, or hypothesis-testing; they could repeat the problem with various different conditions; they could get feedback; . . . in fact the problem is exactly analogous to what every five-year-old learns to do at school when they start giving instructions to each other on how to play a game. It is not a task that is intellectually very demanding.

But what happens in the unnatural environment of a university course? The problem is not solved on the computer. It is set as a pen and paper task. The language is learned by look-up. The mechanism is modelled on paper. Feedback is obtained, not directly from the model, nor from its interpretation in a domain, but from the tutor. And, reasonably enough, the students reconstruct an entirely different problem, i.e. the one afforded by this situation. The problem is no longer one on microelectronics. Their strategies of 'working backwards', 'relating this problem to another familiar one', 'hypothesis testing', 'checking back' etc are all used, i.e. transferred

from their learning about natural environments, but they cannot be deployed to a problem about microelectronics, because it has not been set up that way. It is not microelectronics that is providing the feedback, it is the tutor. So the problem they define for themselves is the problem of getting full marks from this tutor. And that is properly set up. They can work backwards from the kind of solution they know he likes ("box diagrams"), they can use knowledge of similar problems ("look up the one he marked last week"), check back ("how does my answer compare with the one we did in class"), and so on. This is the problem the environment affords. And it has very little to do with microelectronics.

Thus the structures of the environments we offer students often do not afford learning of the precepts we want to convey.

The point is illustrated further by some of the research on students reading academic texts. Students' reports of their reading of a chapter reveal quite alarmingly inappropriate strategies, their main focus being to memorise key words and phrases, with little attempt to integrate the information with previous information, or to discover the structure of the argument. Research studies of this kind have been replicated in several different academic contexts: in different countries, with different age groups, different subject matter etc, and show that the phenomenon of 'surface-level processing' is widespread. It is alarming because it is not a good academic approach to learning a subject. But is it really so inappropriate? From the student's point of view, they have to be able to refer to the right experiments in a psychology paper, quote the right formulae in a physics paper, work in the right events in a history paper. For most students, the inclusion of a quantity of facts is a better guarantee of a good mark than relying on the quality of an argument.

Some of the above studies have found that students' adoption of surface-level processing depends on the context within which they are doing the reading (see Marton et al 1984). By investigating the same student's behaviour over a number of normal academic tasks, it was possible to show that students used surface-level processing when they perceived that that was what the situation, namely the exam or essay, demanded. When they knew they could not get away with mere regurgitation, or when they were motivated by interest in the subject itself, they penetrated further into what the text was about.

It is clear that academics have long recognised the need to attach artificial devices to the academic learning process in order to encourage learning to take place. The educational system has an elaborate array of rewards in the form of exam results, and feedback in the form of marked exercises. The necessary mechanisms for learning have been duly adopted as psychologists discover what they are. But the transfer to the academic environment has not preserved the internal relations between content and feedback. The rewards and the knowledge of results do not come from what is being learned, as they do in a natural environment. They come from something external to the content, namely a tutor. Wanting to get a good mark for the physics test does nothing in itself to help the student understand the physics, except, perhaps, that it directs them to look at the physics book rather than go to the movies.

The consequence of this is that the content being learned as a product of those mechanisms is how to pass exams, how to operate a computer, how to present answers for the marker, how to make a good impression on the tutor, etc. The successful learners are the "cue-seekers" and the "cue-conscious" (Miller & Parlett 1974) - the ones who pick up the cues on how to pass exams. And that would be acceptable if learning how to pass exams implied

that they must have learned the subject. Unfortunately, however, passing an exam often has rather little to do with having a real grasp of the subject. There is some evidence for this. Noel Entwistle's studies, for example, show that A-level is a poor predictor of university results (Entwistle 1974). More recently, Dahlgren's investigations show that students who have obtained good exam results still cannot answer adequately the most basic question in their subject if it is different in style from those they have studied for (Dahlgren & Marton 1978). Students who have been studying economics for three years, and have passed the final exam, cannot answer a question like 'Why does a bun cost 12p?'. The question is different from those they studied for the exam, and students learn what the environment affords. It affords the learning of how to pass exams, and that is not the same as learning the subject.

How is it that some students do manage to learn some physics, history and sociology occasionally? I have argued that what they are offered by the academic profession does not help them. And insofar as it affords anything, it affords the learning of something else entirely. In order to go beyond what the situation offers, students have to adopt a strategy that is capable of penetrating the surface of the text, or the lecture, or the TV programme. Such a strategy has been discerned in student learning behaviour, and has been given the now familiar name 'deep-level processing'. It has been established that the adoption of this strategy relates to an intention to understand the material, and relates empirically to better summaries of the text concerned. Nonetheless, surface-level processing has the character of automaticity that, if the environment were properly structured, would lead to learning of the content. Deep-level processing is a deliberate attempt to destructure the environment as given, in order to penetrate the obscured meaning.

It may be that there is no analogue of deep-level processing in the learning of a natural environment. The meaning of a percept is given in the perception of it. There is no sense in which the perceiver has to go beyond what is afforded to what is hidden. That is what deep-level processing allows the student to do. In the natural environment, the learner's goals and values tend to coincide anyway with the content of learning afforded by the environment: everyone finds the sensation of balancing pleasing, and the social rewards of imitation exciting, so everyone learns to walk and talk. But this aspect of learning does not transfer to the academic environment: in preceptual learning, the learner's goals must not be personal, their values must not be governed by an immediate emotional response to their experience. In order to apprehend the precept at all, the learner must ignore this immediate response, and adjust their goals to coincide with an attention to what the author's goals are, what the author is trying to communicate. Many of the students who summarised the scientific method text as being about the cause of childbed fever described that as being the only point of interest the text had for them. The format of the text, as I suggested, certainly afforded the learning of this precept in a way that it did not afford the learning of the form of scientific method. And for these students, their immediate emotional response coincided with that secondary aspect. So that is what they learned. In order to learn what the text was actually about, it was necessary for them to adopt deep-level processing.

SUMMARY

Where does this lead? To a recognition that the learning of precepts is fundamentally different from learning percepts; that therefore the mechanisms of learning that are derived from the learning of percepts, namely the content of a natural environment, do not transfer directly to the

learning of precepts, namely the content of an academic environment; that students do exhibit the various mechanisms of learning posited by cognitive psychology, but applied to a poorly structured environment they result in poor learning, unless overridden by special strategies; that artificial mechanisms fail because they do not preserve the relations between content and feedback that exist in the natural environment from which they were transferred.

There are two remedies implicit in this account. One is to teach all students deep-level processing - which incidentally only gets them as far as apprehending the correct precepts, not learning them. The other is to reconstruct the academic environments we control so that they do afford learning. For this, we need help from psychology.

Our problem is that at present, cognitive psychology produces generalised, not content-specific principles and theories of learning. The teacher needs help in reinterpreting these for specific content. Usually, of course, the general principles are derived from particular instances, which necessarily concern the learning of some particular content. But they are then generalised, with the particular content screened out. It would be better, from the educationalist's point of view, to leave some trace of the content there in the formulation of the principle, so that it is possible to see what part it plays. A general principle that describes, e.g. the importance of active manipulation, or of relating new knowledge to existing knowledge is no help because it does not clarify the logic of the relationship between the cognitive activity and the content to be learned. We need cognitive psychology to tell us, in a content-specific way, how a natural environment affords learning. Then, perhaps, we can construct the means of access that will turn an unnatural environment into one that affords learning.

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